1,022,352

PATENT SPECIFICATION

DRAWINGS ATTACHED

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COMPLETE SPECIFICATION

Improvements relating to Intercoolers for Rotary Gas Compressors

We, ASSOCIATED ELECTRICAL INDUSTRIES LIMITED, a British Company having its registered office at 33, Grosvenor Place, London, S.W.1., do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to coolers for cooling the gas flowing between the stages of a rotary compressor. Such coolers are usually constructed as appendages mounted exteriorly around the periphery of the compressor casing and are connected between themselves and to the casing by conduits through which the gas flows. Thus the gas is required to flow out of the main casing and is re-introduced after it has been cooled. The complex circuit, part of which is internal, required to achieve this causes a considerable pressure drop between stages. Furthermore, a considerable amount of accurate machining is involved and the assembly is complicated. In addition the weight of the casings containing the coolers is considerable.

The object of the present invention is to provide an arrangement of interstage cooling for a gas compressor which introduces only a small pressure drop, which is simpler and therefore cheaper to produce, and in which there is a saving in weight as compared with the usual prior construction.

According to this invention in a rotary compressor including a rotor mounted within a casing having a plurality of impeller stages and an intercooler between two successive stages, the intercooler comprises an annular cooling structure located within the casing intermediate the impellers of the two successive stages and guide means for directing the gas flow from one stage directly though and around the cooling structure to the input of the next stage, the annular cooling structure consisting of two semi-circular parts each of which parts includes a number of arcuate cooling tubes and means for circulating a cooling medium, for example water, through the tubes. Preferably each semi-circular part is composed of two quadrants each containing a number of arcuate cooling tubes assembled in a framework and connected at adjacent ends to a manifold or header. The outer ends of the tubes are enclosed by end chambers which complete closed circulation paths through the quadrant. The two quadrants are supplied from a common entry connected to the manifold or header with cooling fluid which flows through the tubes in the normal manner. A common outlet for the cooling fluid is connected to the header. Conveniently this outlet comprises an annular passage formed between two concentric tubes, the inner one providing the fluid entry.

A preferred embodiment is illustrated by the drawings filed with the Provisional Specification in which Fig. 1 is a half section through the last two stages of a rotary compressor with the intercooler in position; the arrows indicate the direction of gas flow through the impellers. Fig. 2 is an end view, partly in section, of a cooler quadrant with part of an adjacent quadrant and an interconnecting manifold or header. Fig. 3 is a modification of the header shown in Figs. 1 and 2.

Referring to Fig. 1, the compressor casing is represented in general by the parts 1 in which is rotatably mounted a shaft 2 with the last two impeller stages 3, 3¹ between which is mounted an intercooler 4 constructed in accordance with this invention.

The intercooler assembly 4 is built up of four quadrants, one of which is shown in Fig. 2 by the reference numeral 5, comprising arcuate side plates 6 and 6¹ secured (as by welding to tube end plates 7. It will be seen in Fig. 1 that the side plate 6 on the up-stream side of the cooler (i.e. right hand side of Fig. 1) extends radially about halfway across the tubes, whereas on the down-stream side the plate 6¹ extends for the full radial width. Arcuate cooling tubes 8 are mounted between

plates 6 and 6¹ and emerge through plates 7. Intermediate plates 9 for strengthening the structure may be provided as necessary. For convenience only eight tubes are shown in Fig. 1, but it is understood that in practice the number of tubes may be around 100. To the outer end of the quadrant 5 is secured an end cap 10 which defines a chamber into which the tubes 8 emerge, thereby providing for circulation of cooling fluid.

The inner end (upper end in Fig. 2) of the quadrant is secured to one side of a manifold or header 11 which is divided internally by a transverse partition 12 into inlet and outlet chambers 12*a*, 12*b*. An inlet pipe 13 sealed into plate 12 passes through a concentric outlet pipe 14 sealed into the outer wall of the header. The other side of the header is secured to the end of an adjacent quadrant 5¹, the two quadrants thus forming a substantially semi-circular cooling unit with a common inlet and outlet for the two quadrants. A similar semi-circular unit will be provided in the bottom half casing.

In use, cooling fluid is supplied through inlet pipe 13 to chamber 12*a*, whence is flows as indicated by the arrows 8¹ through the tubes of each quadrant and chambers 10 to header chamber 12*b* and out through pipe 14. The gas flow from impeller 3 is guided within the casing directly through the cooler 4 as shown by the arrows to the inlet eye of impeller 3¹. It will be seen that the gas passage between stages extends over virtually the full 360° and that it is not necessary to guide the gas into localised ducts leading to the cooler, as in previous arrangements. The pressure drop between stages is, therefore, very much lower and the gas distribution far more uniform.

Fig. 3 shows a modified construction of the header of Figs. 1 and 2 designed for a 4-pass cooler; the interior is in this case divided internally by transverse partitions 12¹ into three chambers so as to provide an intermediate chamber 12*c* in addition to the chambers 12*a*, 12*b*. It will be seen by the arrows, when each of the end chambers 10 is internally divided by a transverse partition the cooling fluid passes four times through the cooler instead of twice as in Fig. 2. In other respects the construction is the same.

The tubes 8 will generally be provided with helical fins on the outside in known manner.

A particular advantage of the cooling structure of this invention is that, except for the small proportion of the circumference blocked by the water headers, the cooler tubes extend over the whole of the circumference of the casing, so that every particle of gas from the outlet of the diffusers of one stage to the inlet eye of the next stage travels over almost entirely the same distance and has a similar flow path and, therefore, meets with the same resistance. Consequently every passage or part of the diffuser sees the same outlet conditions and, therefore, behaves in a similar manner to its neighbour, with the result that the machine will have the maximum efficiency. Similarly the gas will be in the same condition of pressure, temperature and direction over the whole of the annulus of the inlet eye to the impeller of the next stage, because the eye of the impeller is fed by gas which comes to it uniformly from almost the complete circumference of the annular cooler.

It will be apparent that if the coolers are merely local appendages to the main casing, the flow path of the gas to the cooler from different passages or parts of the diffuser of one stage will vary considerably. Similarly the flow path from the cooler to different parts of the inlet eye of the next stage will also vary considerably, with perhaps some non-uniform distribution of gas to the impeller eye.

WHAT WE CLAIM IS:—

1. A rotary compressor including a rotor mounted within a casing having a plurality of impeller stages and an intercooler between two successive stages, the intercooler comprising an annular cooling structure located within the casing intermediate the impellers of the two successive stages and guide means for directing the gas flow from one stage directly through and around the cooling structure to the input of the next stage, the annular cooling structure consisting of two semi-circular parts each of which parts includes a number of arcuate cooling tubes and means for circulating a cooling medium through the tubes.

2. A compressor according to Claim 1, wherein each of said semi-circular structure parts is composed of two quadrants each containing a number of arcuate cooling tubes assembled in a framework and connected at adjacent ends of the quadrants to a common manifold, the outer ends of the tubes of each quadrant being enclosed by an end chamber so as to complete closed circulation paths through the quadrant, and common inlet and outlet fluid passages connected to the manifold.

3. A compressor according to Claim 2, wherein the outlet from the manifold comprises an annular passage formed between two concentric tubes the inner one of which provides the inlet to the manifold.

4. A compressor according to Claim 3, wherein the manifold is divided internally by a first transverse partition into inlet and outlet chambers, the inner of said concentric tubes is sealed into the partition and the outer tube is sealed onto an outer wall of the manifold.

5. A compressor according to Claim 4, wherein the manifold is further divided internally by a second transverse partition, disposed radially outwards of the first transverse partition, so as to provide an intermediate chamber between the inlet chamber and the outlet chamber, the said inner concentric tube is sealed into the first and second partitions

and the outer tube is sealed onto the outer wall of the manifold, and each of the end chambers is divided internally by a transverse partition thereby providing a 4-pass flow through the cooling structure.

6. A rotary compressor provided with an interstage cooling structure substantially as described herein and shown in the drawings filed with the Provisional Specification.

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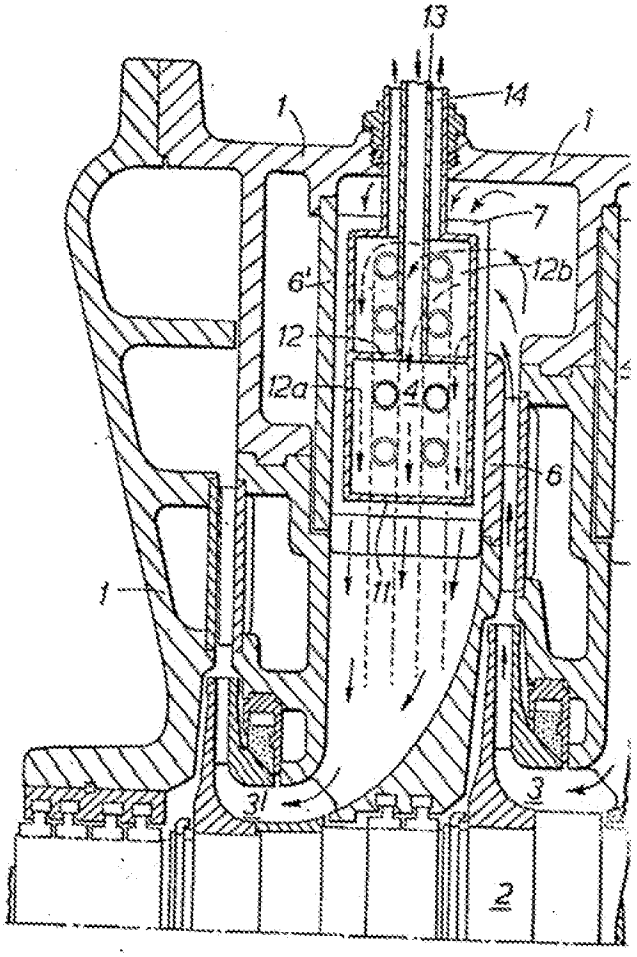
13
14
1
1
7
12b
6'
12
12a
6
1
11
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2 SHEETS *This drawing is a reproduction of the Original on a reduced scale*
Sheets 1 & 2

FIG. 2.

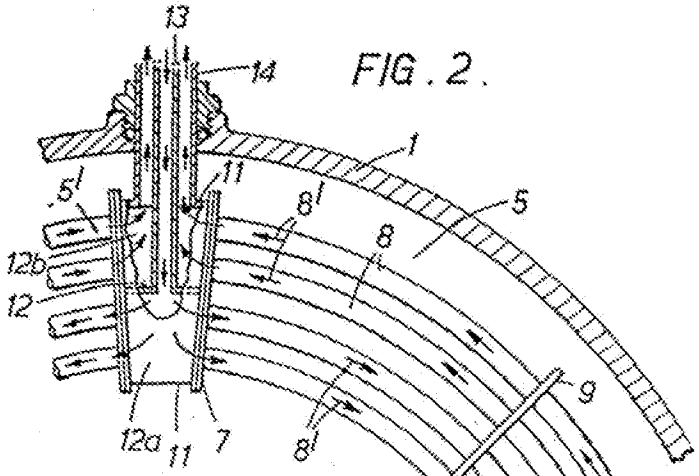
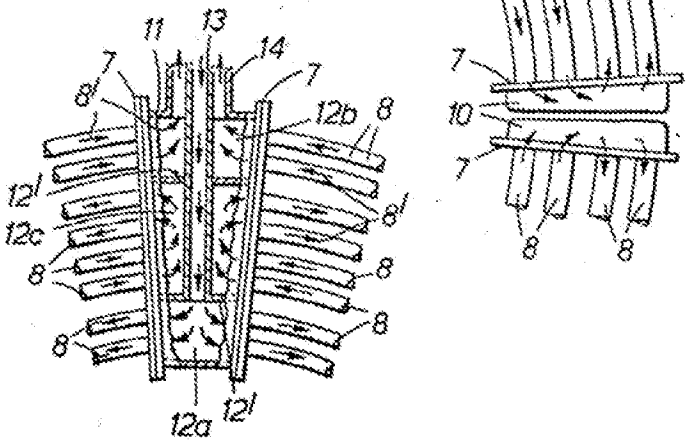


FIG. 3.



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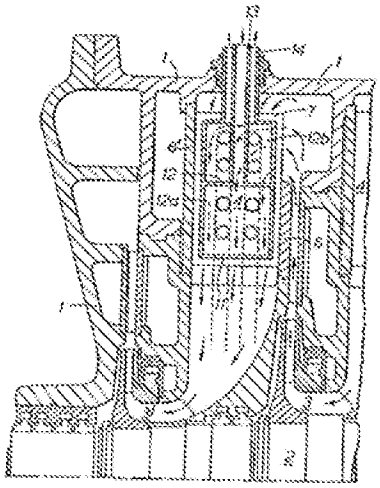

FIG. 2.

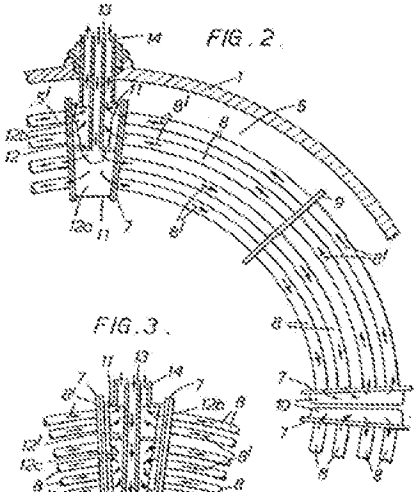

FIG. 3.